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Creation-Science Is Not Science

In December 1981 I appeared as an expert witness for the plaintiffs and the American Civil Liberties Union (ACLU) in their successful challenge of Arkansas Act 590, which demanded that teachers give “balanced treatment” to “creation-science” and evolutionary ideas.¹ My presence occasioned some surprise, for I am an historian and philosopher of science. In this essay, I do not intend to apologize for either my existence or my calling, nor do I intend to relive past victories²; rather, I want to explain why a philosopher and historian of science finds the teaching of “creation-science” in science classrooms offensive.

Obviously, the crux of the issue—the center of the plaintiffs’ case—is the status of creation-science. Its advocates claim that it is genuine science and may, therefore, be legitimately and properly taught in the public schools. Its detractors claim that it is not genuine science but a form of religion—dogmatic Biblical literalism by another name. Which is it, and who is to decide?

It is somewhat easier to describe who should participate in decisions on this issue. On the one hand, one naturally appeals to the authority of religious people and theologians. Does creation-science fit the accepted definitions of a religion? (In Arkansas, the ACLU produced theologians who said that indeed it did.) One also appeals to the authority of scientists. Does creation-science fit current definitions of science? (In Arkansas, the ACLU produced scientists who said that indeed it did not.)³

Having, as it were, appealed to the practitioners—theologians and scientists—a link still seems to be missing. Someone is needed to talk at a more theoretical level about the nature of science—any science—and then show that creation-science simply does not fit the part. As a philosopher and an historian, it is my job to look at science, and to ask precisely those questions about defining characteristics.

FROM *Science, Technology, and Human Values* 7 no. 40 (Summer 1982): 72–78.

■ | What Is Science?

It is simply not possible to give a neat definition—specifying necessary and sufficient characteristics—which separates all and only those things that have ever been called “science.” The concept “science” is not as easily definable as, for example, the concept “triangle.” Science is a phenomenon that has developed through the ages—dragging itself apart from religion, philosophy, superstition, and other bodies of human opinion and belief.⁴

What we call “science” today is a reasonably striking and distinctive set of claims, which have a number of characteristic features. As with most things in life, some items fall on the borderline between science and nonscience (e.g., perhaps Freudian psychoanalytic theory). But it is possible to state positively that, for example, physics and chemistry are sciences, and Plato’s Theory of Forms and Swedenborgian theology are not.⁵

In looking for defining features, the obvious place to start is with science’s most striking aspect—it is an empirical enterprise about the real world of sensation. This is not to say that science refers only to observable entities. Every mature science contains unobservables, like electrons and genes, but ultimately, they refer to the world around us. Science attempts to understand this empirical world. What is the basis for this understanding? Surveying science and the history of science today, one thing stands out: science involves a search for order. More specifically, science looks for unbroken, blind, natural regularities (*laws*). Things in the world do not happen in just any old way. They follow set paths, and science tries to capture this fact. Bodies of science, therefore, known variously as “theories” or “paradigms” or “sets of models,” are collections of laws.⁶

Thus, in Newtonian physics we find Newton’s three laws of motion, the law of gravitational attraction, Kepler’s laws of planetary motion, and so forth. Similarly, for instance, in population genetics we find the Hardy-Weinberg law. However, when we turn to something like philosophy, we do not find the same appeal to empirical law. Plato’s Theory of Forms only indirectly refers to this world. Analogously, religion does not insist on unbroken law. Indeed, religious beliefs frequently allow or suppose events outside law or else events that violate law (miracles). Jesus feeding the 5,000 with the loaves and fishes was one such event. This is not to say that religion is false, but it does say that religion is not science. When the loaves and fishes multiplied to a sufficiency to feed so many people, things happened that did not obey natural law, and hence the feeding of the 5,000 is an event beyond the ken of science.⁷

A major part of the scientific enterprise involves the use of law to effect *explanation*. One tries to show why things are as they are—and how they fall beneath or follow from law (together perhaps with certain specified initial conditions). Why, for example, does a cannon ball go in a

parabola and not in a circle? Because of the constraints of Newton's laws. Why do two blue-eyed parents always have blue-eyed children? Because this trait obeys Mendel's first law, given the particular way in which the genes control eye-color. A scientific explanation must appeal to law and must show that what is being explained had to occur. The explanation excludes those things that did not happen.⁸

The other side of explanation is *prediction*. The laws indicate what is going to happen: that the ball will go in a parabola, that the child will be blue-eyed. In science, as well as in futurology, one can also, as it were, predict backwards. Using laws, one infers that a particular, hitherto-unknown phenomenon or event took place in the past. Thus, for instance, one might use the laws of physics to infer back to some eclipse of the sun reported in ancient writings.

Closely connected with the twin notions of explanation and prediction comes *testability*. A genuine scientific theory lays itself open to check against the real world: the scientist can see if the inferences made in explanation and prediction actually obtain in nature. Does the chemical reaction proceed as suspected? In Young's double slit experiment, does one find the bands of light and dark predicted by the wave theory? Do the continents show the expected after-effects of drift?

Testability is a two-way process. The researcher looks for some positive evidence, for *confirmation*. No one will take seriously a scientific theory that has no empirical support (although obviously a younger theory is liable to be less well-supported than an older theory). Conversely, a theory must be open to possible refutation. If the facts speak against a theory, then it must go. A body of science must be *falsifiable*. For example, Kepler's laws could have been false: if a planet were discovered going in squares, then the laws would have been shown to be incorrect. However, in distinguishing science from nonscience, no amount of empirical evidence can disprove, for example, the Kantian philosophical claim that one ought to treat people as ends rather than means. Similarly, Catholic religious claims about transubstantiation (the changing of the bread and wine into the body and blood of Christ) are unfalsifiable.⁹

Science is *tentative*. Ultimately, a scientist must be prepared to reject his theory. Unfortunately, not all scientists are prepared to do in practice what they promise to do in theory; but the weaknesses of individuals are counterbalanced by the fact that, as a group, scientists do give up theories that fail to answer to new or reconsidered evidence. In the last 30 years, for example, geologists have reversed their strong convictions that the continents never move.

Scientists do not, of course, immediately throw their theories away as soon as any counter-evidence arrives. If a theory is powerful and successful, then some problems will be tolerated, but scientists must be prepared to change their minds in the face of the empirical evidence. In this regard, the scientists differ from both the philosophers and the theologians. Noth-

ing in the real world would make the Kantian change his mind, and the Catholic is equally dogmatic, despite any empirical evidence about the stability of bread and wine. Such evidence is simply considered irrelevant.¹⁰

Some other features of science should also be mentioned, for instance, the urge for simplicity and unification; however, I have now listed the major characteristics. Good science—like good philosophy and good religion—presupposes an attitude that one might describe as professional *integrity*. A scientist should not cheat or falsify data or quote out of context or do any other thing that is intellectually dishonest. Of course, as always, some individuals fail; but science as a whole disapproves of such actions. Indeed, when transgressors are detected, they are usually expelled from the community. Science depends on honesty in the realm of ideas. One may cheat on one's taxes; one may not fiddle the data.¹¹

■ | Creation-Science Considered

How does creation-science fit the criteria of science listed in the previous section? By "creation-science" in this context, I refer not just to the definition given in Act 590, but to the whole body of literature which goes by that name. The doctrine includes the claims that the universe is very young (6,000 to 20,000 years), that everything started instantaneously, that human beings had ancestry separate from apes, and that a monstrous flood once engulfed the entire earth.¹²

LAWS—NATURAL REGULARITIES

Science is about unbroken, natural regularity. It does not admit miracles. It is clear, therefore, that again and again, creation-science invokes happenings and causes outside of law. For instance, the only reasonable inference from Act 590 (certainly the inference that was accepted in the Arkansas court) is that for creation-science the origin of the universe and life in it is not bound by law. Whereas the definition of creation-science includes the unqualified phrase "sudden creation of the universe, energy and life from nothing," the definition of evolution specifically includes the qualification that its view of origins is "naturalistic." Because "naturalistic" means "subject to empirical law," the deliberate omission of such a term in the characterization of creation-science means that no laws were involved.

In confirmation of this inference, we can find identical claims in the writings of creation scientists: for instance, the following passage from Duane T. Gish's popular work *Evolution—The Fossils Say No!*

CREATION. By creation we mean the bringing into being of the basic kinds of plants and animals by the process of sudden, or fiat, creation described in the first two chapters of Genesis. Here we find the creation by God of the plants and animals, each commanded to reproduce after its own kind using processes which were essentially instantaneous.

We do not know how God created, what processes He used, for God used processes which are not now operating anywhere in the natural universe. This is why we refer to divine creation as special creation. We cannot discover by scientific investigations anything about the creative processes used by God.¹³

By Gish's own admission, we are not dealing with science. Similar sentiments can be found in *The Genesis Flood* by John Whitcomb, Jr., and Henry M. Morris:

But during the period of Creation, God was introducing order and organization and energization into the universe in a very high degree, even to life itself! It is thus quite plain that the processes used by God in creation were utterly different from the processes which now operate in the universe! The Creation was a unique period, entirely incommensurate with this present world. This is plainly emphasized and reemphasized in the divine revelation which God has given us concerning Creation, which concludes with these words: 'And the heavens and the earth were finished, and all the host of them. And on the seventh day God finished His work which He had made; and He rested on the seventh day from all His work which He had made. And God blessed the seventh day, and hallowed it; because that in it He rested from all his work which God had created and made.' In view of these strong and repeated assertions, is it not the height of presumption for man to attempt to study Creation in terms of present processes?¹⁴

Creation scientists generally acknowledge this work to be the seminal contribution that led to the growth of the creation-science movement. Morris, in particular, is the father figure of creation-science and Gish his chief lieutenant.

Creation scientists also break with law in many other instances. The creationists believe that the Flood, for example, could not have just occurred through blind regularities. As Whitcomb and Morris make very clear, certain supernatural interventions were necessary to bring about the Flood.¹⁵ Similarly, in order to ensure the survival of at least some organisms, God had to busy himself and break through law.

EXPLANATION AND PREDICTION

Given the crucial role that law plays for the scientist in these processes, neither explanation nor prediction is possible where no law exists.

Thus, explanation and prediction simply cannot even be attempted when one deals with creation-science accounts either of origins or of the Flood.

Even against the broader vistas of biology, creation-science is inadequate. Scientific explanation/prediction must lead to the thing being explained/predicted, showing why that thing obtains and not other things. Why does the ball go in a parabola? Why does it not describe a circle? Take an important and pervasive biological phenomenon, namely, "homologies," the isomorphisms between the bones of different animals. These similarities were recognized as pervasive facets of nature even before Darwin published *On the Origin of Species*. Why are the bones in the forelimbs of men, horses, whales, and birds all so similar, even though the functions are quite different? Evolutionists explain homologies naturally and easily, as a result of common descent. Creationists can give no explanation, and make no predictions. All they can offer is the disingenuous comment that homology signifies nothing, because classification is all man-made and arbitrary anyway. Is it arbitrary that man is not classified with the birds?¹⁶ Why are Darwin's finches distributed in the way that we find on the Galapagos? Why are there 14 separate species of this little bird, scattered over a small group of islands in the Pacific on the equator? On those rare occasions when Darwin's finches do fly into the pages of creation-science, it is claimed either that they are all the same species (false), or that they are a case of degeneration from one "kind" created back at the beginning of life.¹⁷ Apart from the fact that "kind" is a term of classification to be found only in Genesis, this is no explanation. How could such a division of the finches have occurred, given the short span that the creationists allow since the Creation? And, in any case, Darwin's finches are anything but degenerates. Different species of finch have entirely different sorts of beaks, adapted for different foodstuffs—evolution of the most sophisticated type.¹⁸

TESTABILITY, CONFIRMATION, AND FALSIFIABILITY

Testability, confirmation, and falsifiability are no better treated by creation-science. A scientific theory must provide more than just after-the-fact explanations of things that one already knows. One must push out into the frontiers of new knowledge, trying to predict new facts, and risking the theory against the discovery of possible falsifying information. One cannot simply work at a secondary level, constantly protecting one's views against threat: forever inventing *ad hoc* hypotheses to save one's core assumptions.

Creation scientists do little or nothing by way of genuine test. Indeed, the most striking thing about the whole body of creation-science literature is the virtual absence of *any* experimental or observational work by creation scientists. Almost invariably, the creationists work exclusively with the discoveries and claims of evolutionists, twisting the conclusions to their

own ends. Argument proceeds by showing evolution (specifically Darwinism) wrong, rather than by showing Creationism right.

However, this way of proceeding—what the creationists refer to as the “two model approach”—is simply a fallacious form of argument. The views of people like Fred Hoyle and N. C. Wickramasinghe, who believe that life comes from outer space, are neither creationist nor truly evolutionist.¹⁹ Denying evolution in no way proves Creationism. And, even if a more straightforward either/or between evolution and Creationism existed, the perpetually negative approach is just not the way that science proceeds. One must find one’s own evidence in favor of one’s position, just as physicists, chemists, and biologists do.

Do creation scientists ever actually expose their theories and ideas to test? Even if they do, when new counter-empirical evidence is discovered, creation scientists appear to pull back, refusing to allow their position to be falsified.

Consider, for instance, the classic case of the “missing link”—namely, that between man and his ancestors. The creationists say that there are no plausible bridging organisms whatsoever. Thus, this super-gap between man and all other animals (alive or dead) supposedly underlines the creationists’ contention that man and apes have separate ancestry. But what about the australopithecines, organisms that paleontologists have, for most of this century, claimed are plausible human ancestors? With respect, argue the creationists, australopithecines are not links, because they had ape-like brains, they *walked* like apes, and they used their knuckles for support, just like gorillas. Hence, the gap remains.²⁰

However, such a conclusion can be maintained only by blatant disregard of the empirical evidence. *Australopithecus afarensis* was a creature with a brain the size of that of an ape which walked upright.²¹ Yet the creationists do not concede defeat. They then argue that the *Australopithecus afarensis* is like an orangutan.²² In short, nothing apparently makes the creationists change their minds, or allows their views to be tested, lest they be falsified.

TENTATIVENESS

Creation-science is not science because there is absolutely no way in which creationists will budge from their position. Indeed, the leading organization of creation-science, The Creation Research Society (with 500 full members, all of whom must have an advanced degree in a scientific/technological area), demands that its members sign a statement affirming that they take the Bible as literally true.²³ Unfortunately, an organization cannot require such a condition of membership, and then claim to be a scientific organization. Science must be open to change, however confident one may feel at present. Fanatical dogmatism is just not acceptable.

INTEGRITY

Creation scientists use any fallacy in the logic books to achieve their ends. Most particularly, apart from grossly distorting evolutionists’ positions, the creation-scientists frequently use inappropriate or incomplete quotations. They take the words of some eminent evolutionist, and attempt to make him or her say exactly the opposite to that intended. For instance, in *Creation: The Facts of Life*, author Gary E. Parker constantly refers to “noted Harvard geneticist” Richard Lewontin as claiming that the hand and the eye are the best evidence of God’s design.²⁴ Can this reference really be true? Has the author of *The Genetic Basis of Evolutionary Change*²⁵ really foresworn Darwin for Moses? In fact, when one looks at Lewontin’s writings, one finds that he says that *before Darwin*, people believed the hand and the eye to be the effect of direct design. Today, scientists believe that such features were produced by the natural process of evolution through natural selection; but, a reader learns nothing of this from Parker’s book.

What are the essential features of science? Does creation-science have any, all, or none of these features? My answer to this is none. By every mark of what constitutes science, creation-science fails. And, although it has not been my direct purpose to show its true nature, it is surely there for all to see. Miracles brought about by an intervening supervising force speak of only one thing. Creation “science” is actually dogmatic religious Fundamentalism. To regard it as otherwise is an insult to the scientist, as well as to the believer who sees creation-science as a blasphemous distortion of God-given reason. I believe that creation-science should not be taught in the public schools because creation-science is not science.

■ | Notes

1. In fact, Act 590 demanded that *if* one teach[es] evolution, *then* one must also teach creation-science. Presumably a teacher could have stayed away from origins entirely—albeit with large gaps in some courses.
2. For a brief personal account of my experiences, see Michael Ruse, “A Philosopher at the Monkey Trial,” *New Scientist* (1982): 317–319.
3. Judge William Overton’s ruling on the constitutionality (or, rather, unconstitutionality) of Act 590 gives a fair and full account of the various claims made by theologians (including historians and sociologists of religion) and scientists.
4. In my book, *The Darwinian Revolution: Science Red in Tooth and Claw* (Chicago, IL: University of Chicago Press, 1979), I look at the way science was breaking apart from religion in the 19th century.
5. What follows is drawn from a number of basic books in the philosophy of science, including R. B. Braithwaite, *Scientific Explanation* (Cambridge, England:

Cambridge University Press, 1953); Karl R. Popper, *The Logic of Scientific Discovery* (London: Hutchinson, 1959); E. Nagel, *The Structure of Science* (London: Routledge and Kegan Paul, 1961); Thomas S. Kuhn, *The Structure of Scientific Revolutions* (Chicago, IL: University of Chicago Press, 1962); and C. G. Hempel, *Philosophy of Natural Science* (Englewood Cliffs, NJ: Prentice-Hall, 1966). The discussion is the same as what I provided for the plaintiffs in a number of position papers. It also formed the basis of my testimony in court, and, as can be seen from Judge Overton's ruling, was accepted by the court virtually verbatim.

6. One sometimes sees a distinction drawn between "theory" and "model." At the level of this discussion, it is not necessary to discuss specific details. I consider various uses of these terms in my book, *Darwinism Defended: A Guide to the Evolution Controversies* (Reading, MA: Addison-Wesley, 1982).

7. For more on science and miracles, especially with respect to evolutionary questions, see my *Darwinian Revolution*, *op. cit.*

8. The exact relationship between laws and what they explain has been a matter of much debate. Today, I think most would agree that the connection must be fairly tight—the thing being explained should follow. For more on explanation in biology see Michael Ruse, *The Philosophy of Biology* (London: Hutchinson, 1973); and David L. Hull, *Philosophy of Biological Science* (Englewood Cliffs, NJ: Prentice-Hall, 1974). A popular thesis is that explanation of laws involves deduction from other laws. A theory is a body of laws bound in this way: a so-called "hypothetico-deductive" system.

9. Falsifiability today has a high profile in the philosophical and scientific literature. Many scientists, especially, agree with Karl Popper, who has argued that falsifiability is the criterion demarcating science from non-science (see especially his *Logic of Scientific Discovery*). My position is that falsifiability is an important part, but only one part, of a spectrum of features required to demarcate science from non-science. For more on this point, see my *Is Science Sexist? And Other Problems in the Biomedical Sciences* (Dordrecht, Holland: D. Reidel Publishing Company, 1981).

10. At the Arkansas trial, in talking of the tentativeness of science, I drew an analogy in testimony between science and the law. In a criminal trial, one tries to establish guilt "beyond a reasonable doubt." If this can be done, then the criminal is convicted. But, if new evidence is ever discovered that might prove the convicted person innocent, cases can always be reopened. In science, too, scientists make decisions less formally but just as strongly—and get on with business, but cases (theories) can be reopened.

11. Of course, the scientist as citizen may run into problems here!

12. The key definitions in Arkansas Act 590, requiring "balanced treatment" in the public schools, are found in Section 4 [of the Act]. Section 4(a) does not specify exactly how old the earth is supposed to be, but in court a span of 6,000 to 20,000 years emerged in testimony.

The fullest account of the creation-science position is given in Henry M. Morris, ed., *Scientific Creationism* (San Diego, CA: Creation-Life Publishers, 1974).

13. Duane T. Gish, *Evolution—The Fossils Say No!* (San Diego, CA: Creation-Life Publishers, 1973), pp. 22–25, his italics.

14. John Whitcomb, Jr., and Henry M. Morris, *The Genesis Flood* (Philadelphia, PA: Presbyterian and Reformed Publishing Company, 1961), pp. 223–224, their italics.

15. *Ibid.*, p. 76.

16. See Morris, *op. cit.*, pp. 71–72, and my discussion in *Darwinism Defended*, *op. cit.*

17. For instance, in John N. Moore and H. S. Slusher, *Biology: A Search for Order in Complexity* (Grand Rapids, MI: Zondervan, 1977).

18. D. Lack, *Darwin's Finches* (Cambridge, England: Cambridge University Press, 1947).

19. Fred Hoyle and N. C. Wickramasinghe, *Evolution from Space* (London: Dent, 1981).

20. Morris, *op. cit.*, p. 173.

21. Donald Johanson and M. Edey, *Lucy: The Beginnings of Humankind* (New York, NY: Simon and Schuster, 1981).

22. Gary E. Parker, *Creation: The Facts of Life* (San Diego, CA: Creation-Life Publishers, 1979), p. 113.

23. For details of these statements, see [footnote] 7 in Judge Overton's ruling.

24. Parker, *op. cit.* See, for instance, pp. 55 and 144. The latter passage is worth quoting in full:

Then there's 'the marvelous fit of organisms to the environment,' the special adaptations of cleaner fish, woodpeckers, bombardier beetles, etc., etc.,—what Darwin called 'Difficulties with the Theory,' and what Harvard's Lewontin (1978) called 'the chief evidence of a Supreme Designer.' Because of their 'perfection of structure,' he says, organisms 'appear to have been carefully and artfully designed.'

The pertinent article by Richard Lewontin is "Adaptation," *Scientific American* (September 1978).

25. Richard C. Lewontin, *The Genetic Basis of Evolutionary Change* (New York, NY: Columbia University Press, 1974).

LARRY LAUDAN

Commentary: Science at the Bar—Causes for Concern

In the wake of the decision in the Arkansas Creationism trial (*McLean v. Arkansas*)¹ the friends of science are apt to be relishing the outcome. The creationists quite clearly made a botch of their case and there can be little doubt that the Arkansas decision may, at least for a time, blunt legislative pressure to enact similar laws in other states. Once the dust has settled, however, the trial in general and Judge William R. Overton's ruling in particular may come back to haunt us; for, although the verdict itself is probably to be commended, it was reached for all the wrong reasons and by a chain of argument which is hopelessly suspect. Indeed, the ruling rests on a host of misrepresentations of what science is and how it works.

The heart of Judge Overton's Opinion is a formulation of "the essential characteristics of science." These characteristics serve as touchstones for contrasting evolutionary theory with Creationism; they lead Judge Overton ultimately to the claim, specious in its own right, that since Creationism is not "science," it must be religion. The Opinion offers five essential properties that demarcate scientific knowledge from other things: "(1) It is guided by natural law; (2) it has to be explanatory by reference to natural law; (3) it is testable against the empirical world; (4) its conclusions are tentative, i.e., are not necessarily the final word; and (5) it is falsifiable."

These fall naturally into two families: properties (1) and (2) have to do with lawlikeness and explanatory ability; the other three properties have to do with the fallibility and testability of scientific claims. I shall deal with the second set of issues first, because it is there that the most egregious errors of fact and judgment are to be found.

At various key points in the Opinion, Creationism is charged with being untestable, dogmatic (and thus non-tentative), and unfalsifiable. All

FROM *Science, Technology, and Human Values* 7 No. 41 (Fall 1982): 16–19.

three charges are of dubious merit. For instance, to make the inter-linked claims that Creationism is neither falsifiable nor testable is to assert that Creationism makes no empirical assertions whatever. That is surely false. Creationists make a wide range of testable assertions about empirical matters of fact. Thus, as Judge Overton himself grants (apparently without seeing its implications), the creationists say that the earth is of very recent origin (say 6,000 to 20,000 years old); they argue that most of the geological features of the earth's surface are diluvial in character (i.e., products of the postulated worldwide Noachian deluge); they are committed to a large number of factual historical claims with which the Old Testament is replete; they assert the limited variability of species. They are committed to the view that, since animals and man were created at the same time, the human fossil record must be paleontologically co-extensive with the record of lower animals. It is fair to say that no one has shown how to reconcile such claims with the available evidence—evidence which speaks persuasively to a long earth history, among other things.

In brief, these claims are testable, they have been tested, and they have failed those tests. Unfortunately, the logic of the Opinion's analysis precludes saying any of the above. By arguing that the tenets of Creationism are neither testable nor falsifiable, Judge Overton (like those scientists who similarly charge Creationism with being untestable) deprives science of its strongest argument against Creationism. Indeed, if any doctrine in the history of science has ever been falsified, it is the set of claims associated with "creation-science." Asserting that Creationism makes no empirical claims plays directly, if inadvertently, into the hands of the creationists by immunizing their ideology from empirical confrontation. The correct way to combat Creationism is to confute the empirical claims it does make, not to pretend that it makes no such claims at all.

It is true, of course, that some tenets of Creationism are not testable in isolation (e.g., the claim that man emerged by a direct supernatural act of creation). But that scarcely makes Creationism "unscientific." It is now widely acknowledged that many scientific claims are not testable in isolation, but only when embedded in a larger system of statements, some of whose consequences can be submitted to test.

Judge Overton's third worry about Creationism centers on the issue of revisability. Over and over again, he finds Creationism and its advocates "unscientific" because they have "refuse[d] to change it regardless of the evidence developed during the course of the[ir] investigation." In point of fact, the charge is mistaken. If the claims of modern-day creationists are compared with those of their nineteenth-century counterparts, significant shifts in orientation and assertion are evident. One of the most visible opponents of Creationism, Stephen Gould, concedes that creationists have modified their views about the amount of variability allowed at the level of species change. Creationists do, in short, change their minds from time

to time. Doubtless they would credit these shifts to their efforts to adjust their views to newly emerging evidence, in what they imagine to be a scientifically respectable way.

Perhaps what Judge Overton had in mind was the fact that some of Creationism's core assumptions (e.g., that there was a Noachian flood, that man did not evolve from lower animals, or that God created the world) seem closed off from any serious modification. But historical and sociological researches on science strongly suggest that the scientists of any epoch likewise regard some of their beliefs as so fundamental as not to be open to repudiation or negotiation. Would Newton, for instance, have been tentative about the claim that there were forces in the world? Are quantum mechanics willing to contemplate giving up the uncertainty relation? Are physicists willing to specify circumstances under which they would give up energy conservation? Numerous historians and philosophers of science (e.g., Kuhn, Mitroff, Feyerabend, Lakatos) have documented the existence of a certain degree of dogmatism about core commitments in scientific research and have argued that such dogmatism plays a constructive role in promoting the aims of science. I am not denying that there may be subtle but important differences between the dogmatism of scientists and that exhibited by many creationists; but one does not even begin to get at those differences by pretending that science is characterized by an uncompromising open-mindedness.

Even worse, the *ad hominem* charge of dogmatism against Creationism egregiously confuses doctrines with the proponents of those doctrines. Since no law mandates that creationists should be invited into the classroom, it is quite irrelevant whether they themselves are close-minded. The Arkansas statute proposed that Creationism be taught, not that creationists should teach it. What counts is the epistemic status of Creationism, not the cognitive idiosyncrasies of the creationists. Because many of the theses of Creationism are testable, the mind set of creationists has no bearing in law or in fact on the merits of Creationism.

What about the other pair of essential characteristics which the *McLean* Opinion cites, namely, that science is a matter of natural law and explainable by natural law? I find the formulation in the Opinion to be rather fuzzy; but the general idea appears to be that it is inappropriate and unscientific to postulate the existence of any process or fact which cannot be explained in terms of some known scientific laws—for instance, the creationists' assertion that there are outer limits to the change of species "cannot be explained by natural law." Earlier in the Opinion, Judge Overton also writes "there is no scientific explanation for these limits which is guided by natural law," and thus concludes that such limits are unscientific. Still later, remarking on the hypothesis of the Noachian flood, he says: "A worldwide flood as an explanation of the world's geology is not the product of natural law, nor can its occurrence be explained by natural law." Quite how Judge Overton knows that a worldwide flood "cannot"

be explained by the laws of science is left opaque; and even if we did not know how to reduce a universal flood to the familiar laws of physics, this requirement is an altogether inappropriate standard for ascertaining whether a claim is scientific. For centuries scientists have recognized a difference between establishing the existence of a phenomenon and explaining that phenomenon in a lawlike way. Our ultimate goal, no doubt, is to do both. But to suggest, as the *McLean* Opinion does repeatedly, that an existence claim (e.g., there was a worldwide flood) is unscientific until we have found the laws on which the alleged phenomenon depends is simply outrageous. Galileo and Newton took themselves to have established the existence of gravitational phenomena, long before anyone was able to give a causal or explanatory account of gravitation. Darwin took himself to have established the existence of natural selection almost a half-century before geneticists were able to lay out the laws of heredity on which natural selection depended. If we took the *McLean* Opinion criterion seriously, we should have to say that Newton and Darwin were unscientific; and, to take an example from our own time, it would follow that plate tectonics is unscientific because we have not yet identified the laws of physics and chemistry which account for the dynamics of crustal motion.

The real objection to such creationist claims as that of the (relative) invariability of species is not that such invariability has not been explained by scientific laws, but rather that the evidence for invariability is less robust than the evidence for its contrary, variability. But to say as much requires renunciation of the Opinion's other charge—to wit, that Creationism is not testable.

I could continue with this tale of woeful fallacies in the Arkansas ruling, but that is hardly necessary. What is worrisome is that the Opinion's line of reasoning—which neatly coincides with the predominant tactic among scientists who have entered the public fray on this issue—leaves many loopholes for the creationists to exploit. As numerous authors have shown, the requirements of testability, revisability, and falsifiability are exceedingly *weak* requirements. Leaving aside the fact that (as I pointed out above) it can be argued that Creationism already satisfies these requirements, it would be easy for a creationist to say the following: "I will abandon my views if we find a living specimen of a species intermediate between man and apes." It is, of course, extremely unlikely that such an individual will be discovered. But, in that statement the creationist would satisfy, in one fell swoop, all the formal requirements of testability, falsifiability, and revisability. If we set very weak standards for scientific status—and, let there be no mistake, I believe that all of the Opinion's last three criteria fall in this category—then it will be quite simple for Creationism to qualify as "scientific."

Rather than taking on the creationists obliquely and in wholesale fashion by suggesting that what they are doing is "unscientific" *tout court*

(which is doubly silly because few authors can even agree on what makes an activity scientific), we should confront their claims directly and in piecemeal fashion by asking what evidence and arguments can be marshalled for and against each of them. The core issue is not whether Creationism satisfies some undemanding and highly controversial definitions of what is scientific; the real question is whether the existing evidence provides stronger arguments for evolutionary theory than for Creationism. Once that question is settled, we will know what belongs in the classroom and what does not. Debating the scientific status of Creationism (especially when "science" is construed in such an unfortunate manner) is a red herring that diverts attention away from the issues that should concern us.

Some defenders of the scientific orthodoxy will probably say that my reservations are just nitpicking ones, and that—at least to a first order of approximation—Judge Overton has correctly identified what is fishy about Creationism. The apologists for science, such as the editor of *The Skeptical Inquirer*, have already objected to those who criticize this whitewash of science "on arcane, semantic grounds . . . [drawn] from the most remote reaches of the academic philosophy of science."² But let us be clear about what is at stake. In setting out in the *McLean* Opinion to characterize the "essential" nature of science, Judge Overton was explicitly venturing into philosophical terrain. His *obiter dicta* are about as remote from well-founded opinion in the philosophy of science as Creationism is from respectable geology. It simply will not do for the defenders of science to invoke philosophy of science when it suits them (e.g., their much-loved principle of falsifiability comes directly from the philosopher Karl Popper) and to dismiss it as "arcane" and "remote" when it does not. However noble the motivation, bad philosophy makes for bad law.

The victory in the Arkansas case was hollow, for it was achieved only at the expense of perpetuating and canonizing a false stereotype of what science is and how it works. If it goes unchallenged by the scientific community, it will raise grave doubts about that community's intellectual integrity. No one familiar with the issues can really believe that anything important was settled through anachronistic efforts to revive a variety of discredited criteria for distinguishing between the scientific and the non-scientific. Fifty years ago, Clarence Darrow asked, *à propos* the Scopes trial, "Isn't it difficult to realize that a trial of this kind is possible in the twentieth century in the United States of America?" We can raise that question anew, with the added irony that, this time, the pro-science forces are defending a philosophy of science which is, in its way, every bit as outmoded as the "science" of the creationists.

Notes

1. *McLean v. Arkansas Board of Education*, 529 F. Supp. 1255 (E.D. Ark. 1982). For the text of the law, the decision, and essays by participants in the trial, see *7 Science, Technology, and Human Values* 40 (Summer 1982), and also *Creationism, Science, and the Law [The Arkansas Case]*, ed. Marcel C. La Follette (Cambridge, Mass.: MIT Press, 1983).
2. "The Creationist Threat: Science Finally Awakens," *The Skeptical Inquirer* 3 (Spring 1982): 2-5.

MICHAEL RUSE

Response to the Commentary: Pro Judice

As always, my friend Larry Laudan writes in an entertaining and provocative manner, but, in his complaint against Judge William Overton's ruling in *McLean v. Arkansas*,¹ Laudan is hopelessly wide of the mark. Laudan's outrage centers on the criteria for the demarcation of science which Judge Overton adopted, and the judge's conclusion that, evaluated by these criteria, creation-science fails as science. I shall respond directly to this concern—after making three preliminary remarks.

First, although Judge Overton does not need defense from me or anyone else, as one who participated in the Arkansas trial, I must go on record as saying that I was enormously impressed by his handling of the case. His written judgment is a first-class piece of reasoning. With cause, many have criticized the State of Arkansas for passing the "Creation-Science Act," but we should not ignore that, to the state's credit, Judge Overton was born, raised, and educated in Arkansas.

Second, Judge Overton, like everyone else, was fully aware that proof that something is not science is not the same as proof that it is religion. The issue of what constitutes science arose because the creationists claim that their ideas qualify as genuine science rather than as fundamentalist religion. The attorneys developing the American Civil Liberties Union (ACLU) case believed it important to show that creation-science is not genuine science. Of course, this demonstration does raise the question of what creation-science really is. The plaintiffs claimed that creation-science always was (and still is) religion. The plaintiffs' lawyers went beyond the negative argument (against science) to make the positive case (for religion). They provided considerable evidence for the religious nature of creation-science, including such things as the creationists' explicit reliance on the Bible in their various writings. Such arguments seem about as

FROM *Science, Technology, and Human Values* 7 No. 41 (Fall 1982): 19–23.

strong as one could wish, and they were duly noted by Judge Overton and used in support of his ruling. It seems a little unfair, in the context, therefore, to accuse him of "specious" argumentation. He did not adopt the naïve dichotomy of "science or religion but nothing else."

Third, whatever the merits of the plaintiffs' case, the kinds of conclusions and strategies apparently favored by Laudan are simply not strong enough for legal purposes. His strategy would require arguing that creation-science is weak science and therefore ought not to be taught:

The core issue is not whether Creationism satisfies some undemanding and highly controversial definitions of what is scientific; the real question is whether the existing evidence provides stronger arguments for evolutionary theory than for Creationism. Once that question is settled, we will know what belongs in the classroom and what does not.²

Unfortunately, the U.S. Constitution does not bar the teaching of weak science. What it bars (through the Establishment Clause of the First Amendment) is the teaching of religion. The plaintiffs' tactic was to show that creation-science is less than weak or bad science. It is not science at all.

Turning now to the main issue, I see three questions that must be addressed. Using the five criteria listed by Judge Overton, can one distinguish science from non-science? Assuming a positive answer to the first question, does creation-science fail as genuine science when it is judged by these criteria? And, assuming a positive answer to the second, does the Opinion in *McLean* make this case?

The first question has certainly tied philosophers of science in knots in recent years. Simple criteria that supposedly give a clear answer to every case—for example, Karl Popper's single stipulation of falsifiability³—will not do. Nevertheless, although there may be many grey areas, white does seem to be white and black does seem to be black. Less metaphorically, something like psychoanalytic theory may or may not be science, but there do appear to be clear-cut cases of real science and of real non-science. For instance, an explanation of the fact that my son has blue eyes, given that both parents have blue eyes, done in terms of dominant and recessive genes and with an appeal to Mendel's first law, is scientific. The Catholic doctrine of transubstantiation (i.e., that in the Mass the bread and wine turn into the body and blood of Christ) is not scientific.

Furthermore, the five cited criteria of demarcation do a good job of distinguishing the Mendelian example from the Catholic example. Law and explanation through law come into the first example. They do not enter the second. We can test the first example, rejecting it if necessary. In this sense, it is tentative, in that something empirical might change our minds. The case of transubstantiation is different. God may have His own

laws, but neither scientist nor priest can tell us about those which turn bread and wine into flesh and blood. There is no explanation through law. No empirical evidence is pertinent to the miracle. Nor would the believer be swayed by any empirical facts. Microscopic examination of the Host is considered irrelevant. In this sense, the doctrine is certainly not tentative.

One pair of examples certainly do not make for a definitive case, but at least they do suggest that Judge Overton's criteria are not quite as irrelevant as Laudan's critique implies. What about the types of objections (to the criteria) that Laudan does or could make? As far as the use of law is concerned, he might complain that scientists themselves have certainly not always been that particular about reference to law. For instance, consider the following claim by Charles Lyell in his *Principles of Geology* (1830/3): "We are not, however, contending that a real departure from the antecedent course of physical events cannot be traced in the introduction of man."⁴ All scholars agree that in this statement Lyell was going beyond law. The coming of man required special divine intervention. Yet, surely the *Principles* as a whole qualify as a contribution to science.

Two replies are open: either one agrees that the case of Lyell shows that science has sometimes mingled law with non-law; or one argues that Lyell (and others) mingled science and non-science (specifically, religion at this point). My inclination is to argue the latter. Insofar as Lyell acted as scientist, he appealed only to law. A century and a half ago, people were not as conscientious as today about separating science and religion. However, even if one argues the former alternative—that some science has allowed place for non-lawbound events—this hardly makes Laudan's case. Science, like most human cultural phenomena, has evolved. What was allowable in the early nineteenth century is not necessarily allowable in the late twentieth century. Specifically, science today does not break with law. And this is what counts for us. We want criteria of science for today, not for yesterday. (Before I am accused of making my case by fiat, let me challenge Laudan to find one point within the modern geological theory of plate tectonics where appeal is made to miracles, that is, to breaks with law. Of course, saying that science appeals to law is not asserting that we know all of the laws. But, who said that we did? Not Judge Overton in his Opinion.)

What about the criterion of tentativeness, which involves a willingness to test and reject if necessary? Laudan objects that real science is hardly all that tentative: "[H]istorical and sociological researches on science strongly suggest that the scientists of any epoch likewise regard some of their beliefs as so fundamental as not to be open to repudiation or negotiation."⁵

It cannot be denied that scientists do sometimes—frequently—hang

on to their views, even if not everything meshes precisely with the real world. Nevertheless, such tenacity can be exaggerated. Scientists, even Newtonians, have been known to change their minds. Although I would not want to say that the empirical evidence is all-decisive, it plays a major role in such mind changes. As an example, consider a major revolution of our own time, namely that which occurred in geology. When I was an undergraduate in 1960, students were taught that continents do not move. Ten years later, they were told that they do move. Where is the dogmatism here? Furthermore, it was the new empirical evidence—e.g., about the nature of the sea-bed—which persuaded geologists. In short, although science may not be as open-minded as Karl Popper thinks it is, it is not as close-minded as, say, Thomas Kuhn⁶ thinks it is.

Let me move on to the second and third questions, the status of creation-science and Judge Overton's treatment of the problem. The slightest acquaintance with the creation-science literature and Creationism movement shows that creation-science fails abysmally as science. Consider the following passage, written by one of the leading creationists, Duane T. Gish, in *Evolution: The Fossils Say No!*:

CREATION. By creation we mean the bringing into being by a supernatural Creator of the basic kinds of plants and animals by the process of sudden, or fiat, creation.

We do not know how the Creator created, what processes He used, for He used processes which are not now operating anywhere in the natural universe. This is why we refer to creation as Special Creation. We cannot discover by scientific investigations anything about the creative processes used by the Creator.⁷

The following similar passage was written by Henry M. Morris, who is considered to be the founder of the creation-science movement:

... it is ... quite impossible to determine anything about Creation through a study of present processes, because present processes are not created in character. If man wishes to know anything about Creation (the time of Creation, the duration of Creation, the order of Creation, the methods of Creation, or anything else) his sole source of true information is that of divine revelation. God was there when it happened. We were not there ... therefore, we are completely limited to what God has seen fit to tell us, and this information is in His written Word. This is our textbook on the science of Creation!⁸

By their own words, therefore, creation-scientists admit that they appeal to phenomena not covered or explicable by any laws that humans can grasp

as laws. It is not simply that the pertinent laws are not yet known. Creative processes stand outside law as humans know it (or could know it) on Earth—at least there is no way that scientists can know laws breaking (or transcending) Mendel's laws through observation and experiment. Even if God did use His own laws, they are necessarily veiled from us forever in this life, because Genesis says nothing of them.

Furthermore, there is nothing tentative or empirically checkable about the central claims of creation-science. Creationists admit as much when they join the Creation Research Society (the leading organization of the movement). As a condition of membership applicants must sign a document specifying that they now believe and will continue to believe:

(1) The Bible is the written Word of God, and because we believe it to be inspired throughout, all of its assertions are historically and scientifically true in all of the original autographs. To the student of nature, this means that the account of origins in Genesis is a factual presentation of simple historical truths. (2) All basic types of living things, including man, were made by direct creative acts of God during Creation Week as described in Genesis. Whatever biological changes have occurred since Creation have accomplished only changes within the original created kinds. (3) The great Flood described in Genesis, commonly referred to as the Noachian Deluge, was an historical event, worldwide in its extent and effect. (4) Finally, we are an organization of Christian men of science, who accept Jesus Christ as our Lord and Savior. The account of the special creation of Adam and Eve as one man and one woman, and their subsequent fall into sin, is the basis for our belief in the necessity of a Savior for all mankind. Therefore, salvation can come only thru accepting Jesus Christ as our Savior.⁹

It is difficult to imagine evolutionists signing a comparable statement, that they will never deviate from the literal text of Charles Darwin's *On the Origin of Species*. The non-scientific nature of creation-science is evident for all to see, as is also its religious nature. Moreover, the quotes I have used above were all used by Judge Overton, in the *McLean* Opinion, to make exactly the points I have just made. Creation-science is not genuine science, and Judge Overton showed this.

Finally, what about Laudan's claim that some parts of creation-science (e.g., claims about the Flood) are falsifiable and that other parts (e.g., about the originally created "kinds") are revisable? Such parts are not falsifiable or revisable in a way indicative of genuine science. Creation-science is not like physics, which exists as part of humanity's common cultural heritage and domain. It exists solely in the imaginations and writing of a relatively small group of people. Their publications (and stated intentions) show that, for example, there is no way they will relinquish

belief in the Flood, whatever the evidence.¹⁰ In this sense, their doctrines are truly unfalsifiable.

Furthermore, any revisions are not genuine revisions, but exploitations of the gross ambiguities in the creationists' own position. In the matter of origins, for example, some elasticity could be perceived in the creationist position, given the conflicting claims that the possibility of (degenerative) change within the originally created "kinds." Unfortunately, any open-mindedness soon proves illusory; for creationists have no real idea about what God is supposed to have created in the beginning, except that man was a separate species. They rely solely on the Book of Genesis:

And God said, Let the waters bring forth abundantly the moving creature that hath life, and the fowl that may fly above the earth in the open firmament of heaven.

And God created great whales, and every living creature that moveth, which the waters brought forth abundantly, after their kind, and every winged fowl after his kind: and God saw that it was good.

And God blessed them, saying Be fruitful, and multiply, and fill the waters in the seas, and let fowl multiply in the earth.

And the evening and the morning were the fifth day.

And God said, Let the earth bring forth the living creature after his kind, cattle, and creeping thing, and beast of the earth after his kind: and it was so.

And God made the beast of the earth after his kind, and cattle after their kind, and everything that creepeth upon the earth after his kind: and God saw that it was good.¹¹

But the *definition* of "kind," what it really is, leaves creationists as mystified as it does evolutionists. For example, creationist Duane Gish makes this statement on the subject:

[W]e have defined a basic kind as including all of those variants which have been derived from a single stock. . . . We cannot always be sure, however, what constitutes a separate kind. The division into kinds is easier the more the divergence observed. It is obvious, for example, that among invertebrates the protozoa, sponges, jellyfish, worms, snails, trilobites, lobsters, and bees are all different kinds. Among the vertebrates, the fishes, amphibians, reptiles, birds, and mammals are obviously different basic kinds.

Among the reptiles, the turtles, crocodiles, dinosaurs, pterosaurs (flying reptiles), and ichthyosaurs (aquatic reptiles) would be placed in different kinds.

Each one of these major groups of reptiles could be further subdivided into the basic kinds within each.

Within the mammalian class, duck-billed platypus, bats, hedgehogs, rats, rabbits, dogs, cats, lemurs, monkeys, apes, and men are easily assignable to different basic kinds. Among the apes, the gibbons, orangutans, chimpanzees, and gorillas would each be included in a different basic kind.¹²

Apparently, a "kind" can be anything from humans (one species) to trilobites (literally thousands of species). The term is flabby to the point of inconsistency. Because humans are mammals, if one claims (as creationists do) that evolution can occur within but not across kinds, then humans could have evolved from common mammalian stock—but because humans themselves are kinds such evolution is impossible.

In brief, there is no true resemblance between the creationists' treatment of their concept of "kind" and the openness expected of scientists. Nothing can be said in favor of creation-science or its inventors. Overton's judgment emerges unscathed by Laudan's complaints.

■ | Notes

1. For the text of Judge Overton's Opinion, see 7 *Science, Technology, and Human Values* 40 (Summer 1982): 28–42; and *Creationism, Science, and the Law* [Cambridge, Mass.: MIT Press, 1983].
2. Larry Laudan, "Commentary: Science at the Bar—Causes for Concern," [p. 52 this volume].
3. Karl Popper, *The Logic of Scientific Discovery* (London: Hutchinson, 1959).
4. Charles Lyell, *Principles of Geology*, Volume I (London: John Murray, 1830), p. 162.
5. Laudan, *op. cit.*, [p. 50 this volume].
6. Thomas Kuhn, *The Structure of Scientific Revolutions* (Chicago, IL: University of Chicago Press, 1962).
7. Duane Gish, *Evolution: The Fossils Say No!*, 3rd edition (San Diego, CA: Creation-Life Publishers, 1979), p. 40 (his italics).
8. Henry M. Morris, *Studies in the Bible and Science* (Philadelphia, PA: Presbyterian and Reformed Publishing Company, 1966), p. 114.
9. Application form for the Creation Research Society, reprinted in Plaintiffs' trial briefs, *McLean v. Arkansas* (1981).

10. See, for instance, Henry M. Morris, *Scientific Creationism* (San Diego, CA: Creation-Life Publishers, 1974); and my own detailed discussion in Michael Ruse, *Darwinism Defended: A Guide to the Evolution Controversies* (Reading, MA: Addison-Wesley, 1982).

11. Genesis, Book I, Verses 20–25.

12. Gish, *op. cit.*, pp. 34–35.